Virtual Simulated Patients for Bioterrorism Preparedness Training

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1. Background/Problem:

Prior to the Anthrax outbreaks of 2001, a need for better training of medical, emergency-response, and public health personnel in responding to mass casualties from terrorist incidents had been identified [1]. Last year, Catlett et al. [2] reported that educational interventions have been more effective when they have combined interactive techniques, such as case discussion, simulated patients, and hands-on workshops. Furthermore, 75% of family physicians surveyed last fall said they were not prepared to respond to a bioterrorist attack [3]. To meet this need, we developed and evaluated a patient simulator for training clinicians in identifying and treating bioterrorism diseases.

2. Patient Simulator

The bioterrorism patient simulator, called VirtualClinic, follows a **S**ubjective, **O**bjective, **A**ssessment, and **P**lan (SOAP) model for primary care. The VirtualClinic user interface comprises a menu bar across the top of the screen, a 3-D interactive window frame for graphical presentation of the virtual patient, tabbed window frames for accumulation of medical records and presentation of public health alerts, and a command and navigational window frame to direct patient behaviors and provide alternative patient views.

In the **Subjective** section of the menus, the clinician can query the patient about present illness, past medical history, social and family history, lifestyle and medical risks, and symptoms according to body systems. The patient verbalizes his response (using a text-to-speech processor) and might show a related expressive behavior. A definitive textual response is then recorded (and displayed) in the medical record (window).

In the **Objective** section, the clinician can conduct a physical examination according to body systems, order diagnostic tests (e.g., ECG, chest x-ray, CT scan) and clinical laboratory tests (e.g., Gram stains, urinalysis, blood chemistries). Test results, such as Gram stains, radiograms, and electrocardiograms, are presented via a pop-up window frame. For each objective query, a definitive textual response is also recorded in the medical record (e.g., chest x-ray: pulmonary effusions). Laboratory results are presented along with the expected normal range for the measurement, and results that are outside normal limits are highlighted.

Simulated patient with cutaneous anthrax in VirtualClinic

In the **Assessment** section, the clinician can make diagnostic hypotheses. The disease table comprises a set of 1,500 expected diseases in primary care, augmented with additional bioterrorism and emerging diseases. Multiple disease hypotheses can be specified, and each is recorded in the medical record. Whenever a definitive diagnosis is available, the clinician can reenter the differential diagnosis form and remove incorrect diagnoses from the list.

In the **Plan** section, the clinician prescribes medications, provides patient education, schedules follow-up visits, makes referrals, and ultimately disposes of the patient. The clinician can prescribe multiple medications, and each is recorded in the medical record. Referrals can be ordered to any of 16 medical specialists.

The medical record contains demographic information, the chief complaint, and a panel of vital signs (presumably taken by a nurse). All inquiries, patient interactions, diagnostic tests, disease hypotheses, prescriptions, and other plans are automatically accumulated in the medical record as the clinician performs each task. Clinical laboratory results are presented along with their expected normal ranges; such results are highlighted whenever the clinical data are outside normal limits. Laboratory test panels (e.g., lipid panel) are highlighted to indicate that all data came from the same sample.

A public health alerts window contains public health information in the form of a “Blast Fax” alert associated with the current scenario. This helps remind clinicians to read their public health alerts, because such alerts may contain clues to patient diagnosis. The public health alert frame shares screen space with the medical record window frame. The clinician uses a tab metaphor to switch between the two frames.

3. Evaluation

Evaluation methods included scripted scenarios, pre- and post-test questionnaires, data logs, user commentary, and test monitor observations. The methods and data collection instruments were adapted from previous usability analyses of virtual reality-based training software [3]. Six physicians served as our testers; 5 were experienced internal medicine or infectious disease specialists, and the 6th was a recent medical school graduate. The physicians were asked to rate the software attributes on a scale ranging from 1 (lowest or poorest) to 5 (highest or best). They were also asked to suggest specific improvements, and to give a second rating assuming that such improvements were made. This process allowed us to assess the relative contribution of various improvements to the final product, and to guide potential investment of resources to making such improvements.

4. Results

The results of the physician's evaluation are as follows: means and [range]:

	Use after an index case	Use after suspected event	Use for self education	Use as a training tool	User interface	Overall Rating
As Tested	2.9 [2 to 4.5]	2.8 [2 to 4]	2.5* [1 to 3]	3.3 [2 to 4]	3.5 [2 to 5]	**3.6** **[2 to 4.8]**
With Suggestions	2.9 [2 to 4.5]	2.8 [2 to 4]	3.3* [2 to 5]	4.2 [3 to 5]	3.6 [2 to 5]	**4.0** **[3 to 4.8]**

*Two reviewers stated they had sufficient bioterrorism knowledge, and therefore would not use tool for further training.

5. Conclusions

A virtual reality-based simulator has been developed for clinicians to practice interacting with bioterrorism patients. Users testing the software rated it moderately high to very high, with the caveat that certain improvements are made prior to usage among practicing physicians. By providing VirtualClinic to family practitioners nationwide, such primary care clinicians may be better prepared to respond to future bioterrorism events.

6. References

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